3D Graphics and Animation

(Career & Technical Education) Standards and Objectives

A Project of the Utah State Office of Education

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FOREWORD

The 3D Graphics and Animation course was developed at the request of multimedia teachers in the field. Computer Technology and Multimedia I are the prerequisites for this course. Additional art courses are highly recommended particularly courses that include drawing concepts.

For further assistance with issues related to CTE programs in multimedia, contact the Career and Technical Education Division of the Utah State Office of Education at (801) 538-7840.

ACKNOWLEDGMENTS

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3D Graphics and Animation

Grade Levels: 11-12
Units of Credit: 1
CIP Code: 11.0215
Prerequisites: Computer Technology and Multimedia I: Design and Development
Skill Certification Exam: #818

COURSE DESCRIPTION

3D Graphics and Animation is a one-year course with a prerequisite of computer technology and multimedia I. Students will use 3D graphics software to produce 3D models and animations. This course will introduce students to 2D and 3D modeling, animation planning, storyboard development, the creation and application of textures, mapping, lighting, camera and animation of 3D models.

COURSE STANDARDS AND OBJECTIVES

STANDARD
110215-01   Students will identify the applications of 3D Graphics and Animation through exploring the career opportunities and the relevant history of the industry.

<u>OBJECTIVES</u>
110215-01<u>01</u> Identify the various applications of 3D graphics and animation.
- Entertainment
  - Movies
  - Gaming
- Health Sciences
- Architecture
- Aerospace
- Advertising
- Law Enforcement

11-0215-01<u>02</u> Develop career awareness related to working in the 3D graphics industry.
- Identify personal interests and abilities related to 3D Graphics careers
  - Identify personal creative talents
  - Identify organizational and leadership skills
  - Identify special interest areas
- Identify 3D graphics and animation job titles
  - *Animator*
  - *Industrial Designer*
  - *3D Modeler*
  - *Technical Director*
- Investigate career opportunities, trends, and requirements related to 3D graphics and animation careers
  - Identify the members of a 3D graphics and animation team:
  - Investigate trends associated with 3D graphics and animation careers
  - Develop a realistic Student Education Occupation Plan (*SEOP*) to help guide further educational pursuits

- Identify factors for employability and advancement in 3D careers
    - Survey existing 3D graphics and animation businesses to determine what training is required
    - Survey universities and colleges to determine programs, degrees and training availability
    - Develop employability competencies/characteristics: responsibility, dependability, ethics, respect, and cooperation
    - Achieve high standards of personal performance with a positive work ethic and attitude

110215-0103 Discuss the relevant history of the 3D graphics and animation industry.
(PowerPoint)

STANDARD
110215-02 Students will create a basic 3D model as an introduction to the 3D development process.

OBJECTIVES:
110215-0201 Introduce basic 3D terminology and the 3D application interface.

110215-0202 Create a 3D model. (Include modeling, surface materials, camera, lighting, moving, scaling, animation and rendering)

110215-0203 Create an environment/background.

STANDARD
110215-03 Students will model 3D objects.

OBJECTIVES
110215-0301 Introduce pertinent terminology.

110215-0302 Use and manipulate 2D graphics and Primitives.

110215-0303 Create, use and manipulate shapes.

110215-0304 Edit models.
- Extrusion
- Boolean
- Beveling
- Lathe/Revolve
- Grouping
- Model Hierarchy (parent/child)
- Reshape/Convert
- Duplication/Mirroring
- Pivot/Origin Points
- Making a surface from Curves (lofting/skinning)
- Subdivision
- Modifying
    - Edges
    - Faces
    - Vertices
- Use a reference graphic/image/drawing (background)
- Edit an object after its been created (history)
- Other software specific tools

STANDARD
110215-04   Students will apply surface materials to 3D models.

OBJECTIVES
110215-0401   Introduce pertinent terminology.

110215-0402   Create, Apply and edit surface materials.
- Color
- Texture
- Procedurals
- Luminosity
- Transparency
- Reflective
- UV Mapping

STANDARD
110215-05   Students will apply lighting and camera techniques to achieve intended effects.

OBJECTIVES
110215-0501   Introduce pertinent terminology.

110215-0502   Apply lighting effects.
- Basic three point lighting
  - Key
  - Fill
  - Rim
- 3D specific lighting sources
  - Global
  - Directional
  - Spot Lights
  - Shadows/Shading
  - Caustics
  - Point Light
- Lighting techniques (mood etc.)

110215-0503   Apply camera effects.
- Focal Length
- Aspect Ratio/Film Back
- Setting and modifying camera views
  - Staging and Manipulating
  - Truck
  - Pan
  - Zoom
  - Dolly

STANDARD
110215-06   Students will animate 3D models.

OBJECTIVES
110215-0601   Introduce pertinent terminology.

110215-0602   Introduce and apply the mechanics of animation.
- Frame Rate
- Keyframing

- Cycle Animation
- Pivot/Origin Points
- Forward Kinematics Inverse Kinematics (FKIK) Constraints
- Editing Time line
- Rigging
- Linking
- Deformation Graphing
- Path Animation

110215-0603   Introduce and apply various animation effects.
- Particle Systems
- Environmental Simulations
  - Wind
  - Gravity
  - Time
- Other software specific effects.

110215-0604   Introduce and apply the principles of animation.
- Drawing Concepts
- Character Appeal
- Anticipation
  - Action/Reaction
- Exaggeration
- Squash and Stretch
- Timing/Spacing
- "Straight Ahead" and "Pose to Pose"
  - Keyframes
  - In betweens
  - Break downs
- Staging
  - How to set up a scene
  - Camera placement
  - How to tell the story
- Overlap, drag and follow through
- Arcs
- "Slow in, Slow out"
- Secondary Actions
  - Things happening on peripherals

STANDARD
110215-07   Students will render 3D models.

OBJECTIVES
110215-0701   Introduce pertinent terminology.

110215-0702   Introduce and apply the mechanics of rendering.
- Raycasting vs Raytracing
- Optimization
  - Layering
- Shadows/Lighting
- Output
  - File Types
  - Resolution
  - Destinations
  - Naming Conventions

STANDARD
110215-08   Students will demonstrate the process of creating 3D animation. (PowerPoint etc.)

OBJECTIVES
110215-08<u>01</u> Introduce Pertinent Terminology.

110215-08<u>02</u> Demonstrate the animation process.
- Project Brief
- Story
  - Script writing
- Style
  - Story Conceptualization
  - Character, Set and Prop Design
    - Genre
    - Color/Value
    - Mood (light)
    - Clothing
    - Vehicles
    - Architecture
- Storyboards
- Dialog Recording
- Animatic/Story Reel
- Scene Blocking
- Modeling
- Rigging
- Mapping/Texturing
- Lighting
- Animating
- Rendering
- Effects
- Compositing

UTAH ATE SKILL CERTIFICATION
STUDENT PERFORMANCE EVALUATION
Test Number: #818 Test Name: 3D Graphics and Animation

(PRINT) Student's Name: _____ Date: _____

(PRINT) Teacher's Name: _____ School: _____

Teacher's Signature: _____ District: _____

The performance evaluation **is a required component of the skill certification process**. Each student must be evaluated on the required performance objectives below. Performance objectives may be completed and evaluated anytime during the course. Students who achieve a 3 or 4 (moderately to highly skilled) on **ALL** performance objectives, and 80% on the written test will be issued and ATE skill certificate.

Instructions

- Students should be aware of their progress throughout the course, so that they can concentrate on the objectives that need improvement.
- Students should be encouraged to repeat the objectives until they have performed at a minimum of a number **3 or 4 on the rating scale (moderately to highly skilled level)**.
  - 4 = highly skilled   Successfully demonstrated without supervision
  - 3 = moderately skilled   Successfully demonstrated with limited supervision
  - 2 = limited skill   Demonstrated with close supervision
  - 1 = not skilled   Demonstration requires direct instruction and supervision
- When a performance objective has been achieved at a minimum of 80% (moderately to highly skilled level), "**Y" (Y=YES)** is recorded on the performance summary evaluation form. If a student does not achieve a 3 or a 4 (moderately to highly skilled level), then an "**N"(N=NO)** is recorded on the summary sheet for that objective.
  - All performance objectives **MUST** be completed and evaluated prior to the written test.
  - The teacher will bubble in "**A**" on the ATE skill certification answer sheet (SCANTRON) for item **#81** for students who have achieved "**Y**" on **ALL performance objectives**.
  - The teacher will bubble in "**B**" on the ATE skill certification answer sheet (SCANTRON) for item **#81** for students who have **ONE or more "N's"** on the performance objectives.
- The signed evaluation sheet(s) **MUST** be kept in the teacher's file for two years.
- A copy is also kept on file with the schools ATE skills certification testing coordinator for two years.

3D Graphics and Animation
Performance Objectives

Yes		No		
4	**3**	**2**	**1**	**Standard 1 –** Students will identify the applications of 3D Graphics and Animation through exploring the career opportunities and the relevant history of the industry.
				☐ Identify career opportunities in the *3D graphics and animation* industry ☐ Demonstrated employability skills such as responsibility, dependability, ethics, respect and cooperation ☐ Performed with a positive work ethic and attitude ☐ Developed a realistic Student Education Occupation Plan (*SEOP*) to guide further educational/occupational pursuits

Yes		No		
4	**3**	**2**	**1**	**Standard 2 –** Students will create a basic 3D model as an introduction to the 3D development process.
				☐ Created a basic 3D model that includes: • Objects • Surface Materials • Camera • Lighting • Animation • Rendering

Yes		No		Standard 3 – Students will model 3D objects.
4	3	2	1	
				☐ Created 3D models using primitives ☐ Created 3D models using splines ☐ Edited 3D models

Yes		No		Standard 4 – Students will apply surface materials to 3D models.
4	3	2	1	
				☐ Applied mapping to 3D objects ☐ Applied prebuilt textures to 3D objects ☐ Created, applied and edited custom built textures

Yes		No		Standard 5 – Students will apply lighting and camera techniques to achieve intended effects.
4	3	2	1	
				☐ Applied the 3 point lighting system to 3D models ☐ Added, edited and moved lights around 3D models to create desired effects ☐ Used lighting to create mood and atmosphere ☐ Animated a camera

Yes		No		Standard 6 – Students will animate 3D models.
4	3	2	1	
				☐ Demonstrated keyframing and the use of a timeline ☐ Demonstrated cycle animation ☐ Created an animation path

Yes		No		Standard 7 – Students will render 3D models.
4	3	2	1	
				☐ Rendered a high quality final project in an appropriate output format

Yes		No		Standard 8 – Students will understand and demonstrate the process of creating 3D animation.
4	3	2	1	
				☐ Demonstrated the 3D animation development process

3D Graphics and Animation
Glossary of Terms

Algorithm: A recursive mathematical procedure.

Alpha Channel: An eight-bit channel in the 32-bit color image which is used to store transparency data.

Ambient Light: Light that is present in the environment. It has no focus or direction.

Animatic:

Anti-Aliasing: A process that smooths the edges of shapes, such as letters, on a computer screen. *Anti-aliasing* makes jagged edges look smooth by filling in the jags with a similar color.

Aspect Ratio: The width and height of the frame dimensions of an image.

Attributes: Information related to what the node is designed to do.

AVI: (Audio Video Interleaved) A Windows file format for digital video and audio.

Bezier Splines: Lines that are curved or capable of being curved. The curve of the is defined by vertex points.

Bitmap (raster): (Also known as a pixel image) An image is stored as a collection of pixels. May be any resolution or color depth.

Blinn shading: Provide high-quality specular highlights on surfaces.

Bounding Box: An imaginary rectangle that exactly encloses the geometry of an object or group of objects. When a object is selected, handles appear at the corners and midpoints of the sides of this rectangle. when object is manipulated using one of the object-handling tools, its bounding box appears to interact with the tool and provide visual feedback during the tool operation.

Break downs:

CAD: An acronym for Computer-Aided-Design.

Cartesian Coordinate system: A system where a point is located in space by a set of three coordinates representing the distance along three perpendicular axis labeled X, Y, Z.

Click: To position a tool cursor in a view, and usually on an object, then pressing the mouse button. This event initiates a process or operation related to the tool's function.

Click-and-Drag: The process of clicking the mouse button and, while holding the mouse button down, dragging the cursor in the view. For example, this procedure would be used to move an object from one location to another.

CODEC: Compression/decompression of video.

Color Depth: The number of bits required to define the color of each pixel in an image. Black and white images use one bit. Grayscale images use eight bits (256 shades of gray). Eight-bit color images provide 256 colors. Images with 24-bits provide millions of colors (eight bits for each color: red, green, blue). Images with 32 bits provide an additional eight bits for alpha data.

Components: Smaller parts of a primitive such as control vertices, faces, and hulls.

Control Vertices: Describe the shape of an object on their position in space.

Cursor: An icon indicating the current tool selected and/or the current focus of the program.

Cycle: An animation that can seamlessly repeat an infinite number of times.

Database: The area of memory within the program while it is running that is set aside to keep track of objects within a model.

Default: A parameter or setting pre-defined in the program which may be changed by the user.

Diffuse Reflection: That component of the light reflecting from a surface caused by its dull or matte nature. Dull or matte surfaces reflect the light striking them in random angles over a large area, giving the surface an equally-bright appearance from a wide range of viewing positions.

Dither: To blend transitions between colors by placing small dots of black, white, or other colors to simulate those colors that can't be represented because of limits on the numbers of colors available.

Dolly: Moving towards or away from a scene.

Double Click: The act of positioning the cursor on an object in the active view or an icon in the interface, then pressing and releasing the mouse button twice in rapid succession.

DPI (dpi): An abbreviation for dots per inch.

EPS: Short for encapsulated PostScript?, a file format for graphics. EPS format contains all of the code necessary to print a file.

Extension: A modular software program that expands the capabilities of the existing software. The extension functions as if it were part of the original program.

Extrusion: A method of creating a 3-D object using a 2-D template; giving depth to the 2-D shape.

File Compression: The process of reducing the amount of storage space used by a file.

Filter: A routine for altering images.

Flat Shading: Shading by filling each facet of a surface with a single color.

Gradient: A feature that adds color or tint that varies smoothly from one color or brightness to another.

Ground Plane: The reference surface in a scene indicating the floor. Often used to receive shadows.

Group: A collection of objects that act as one.

Hierarchical Object: Creating an object shape in a separate work space which, when inserted into the model, retains a link to the shape. Changes made to the shape are automatically applied to the instances.

Hierarchy: Collection of nodes or objects that are connected together to form a unit.

Hue: The property of color which corresponds to the frequency or wavelength of the light.

Hypergraph: Displays the hierarchy for all of the objects in the scene.

In betweens:

Instance: A replica of a shape. Each time a shape is inserted into a window, an instance of the shape is actually inserted. Any changes made later to the original shape are reflected in each instance, or occurrence, of the shape. Changes made to the instance, however, do not in any way affect the root shape.

Isoparms: Vertical curves of a NURB. It shoes the outline of the surface shape.

Jaggies: Refers to the jagged edges formed in the diagonal or circular lines of bitmapped images.

JPEG: Short for Joint Photographic Experts Group, a committee that has been developing a compression standard for still images. This term also refers to the compression method developed by that group.

Key Light: The primary light source illuminating a scene.

Lathing: A method of creating a 3-D object by revolving a 2-D profile about a designated axis.

Lattice: A structure of points for carrying out free-form deformations on any deformable object.

Luminance: The amount of light radiated by a monitor. It refers to intensity or brightness.

Marquee: A rectangular dotted box created by dragging the cursor. Marquees appear in the programs windows or views to provide visual feedback during various tool operations.

Mesh Surface: A surface that has common vertex points between adjacent polygons. Mesh surfaces are typically used to define complex forms. The surface also provides smoothing information for the rendering algorithms.

Node: A representation of an object or set of objects in which all information for that object(s) is referenced.

Normals: The mathematical value that indicates the direction a surface is facing in 3-D space. Normals may be attached to individual polygons or to the vertex points that define the polygons.

NURBS: (Non Uniform Rational B-Spline) A surface curve controlled by CVs (Control Vertices)

Octree: An internal data structure used to subdivide the model space for more efficient handling.

Origin: The center of the world space. These coordinates are 0,0,0.

Orthographic View: A two-dimensional view of a 3D image. View of only two axes. (front XY, side, etc.)

Parent/Child Link: An internal connection between two objects, in which the child is linked to the parent for constraint purposes. Various uses exist in different applications for linked objects, but are usually related to animation.

Penumbra: A partial shadow between regions of total shadow and total illumination.

Perspective View: A three-dimensional view of a model.

Pict: The standard file format used by Macintosh for storing graphics using Apple's QuickDraw imaging routines.

Pivot Point: A specific position in 3D space that is used as a reference for the transformation of objects

PIXEL: An acronym that stands for Picture Element. It is the smallest component which makes up the display on a computer monitor. Each dot on the screen is a pixel. Many images displayed on the screen are likewise stored in a pixel form that is mapped to the screen pixels for viewing.

Pointcloud: A rendering method used primarily for displaying the model in the modeling window. Only the vertices are rendered.

Point Light: A local source of illumination that shines in all directions from a single point.

Pole: Region where many isoparms converge at a singe point.

Polygon: Forms made of flat surfaces. A closed plane bounded by three or more line segments.

Polygon Mesh: 3 or more flat sided polygon faces.

Primitives: Basic geometric elements from which complex objects can be built.

Raytracing: A rendering algorithm which simulates the physical and optical properties of light rays as they reflect off objects in a 3-D model. This method of rendering typically traces rays of light backward from the imaging plane toward the light sources.

Reflectivity: The percentage of the total amount of light striking the surface that reflects from, or bounces off, the surface of the object.

Refraction: The change in direction of light as it passes from one transparent material to another. This causes an apparent shift in the image showing through the transparent material.

Rendering: The process of calculating an image from all scene information (cameras, objects, materials, lights etc.). A visual representation (photo realistic) of the model.

Resolution: The number of pixels per unit. The higher the number of pixels, the higher the resolution, and the greater the capability to display details.

RGB: A method of representing all colors as the combination of red, green, and blue light.

Saturation: The extent to which a color is made purely or a particular hue; the vividness of the hue.

SEOP: Student Education Occupation Plan. An interest/occupation plan set up for a student by a school counselor, the student, and the student's parents to give guidance to the student in planning the courses he/she will be taking in high school, as well as to provide guidance for the student's post-high school goals.

Specular Reflection: That component of the light reflecting from a surface caused by its shiny or glossy nature. Shiny surfaces reflect light striking them in clearly defined angles of incidence; resulting in "hot spots" corresponding to the direction of the light sources providing the illumination.

Spline: A curve using control vertices (not necessarily on the curve) to define its shape.

Surface Mapping: A process in which an image is used to define an object's surface properties. A separate map is used to define color, texture, reflectivity, transparency.

Spotlight: A local source of illumination which shines in only one direction.

Sweep: A method of creating a 3-D object from a 2-D template using a combination of lathe and extrude. The template is both pushed through space and revolved around an axis at the same time to create a geometrically complex shape. This type of modeling would be used to create the threads on a bolt, for example.

Texture: The surface quality of feel of an image. Texturing an image can add an appearance of smoothness, roughness, softness, etc.

TIFF: Short for Tagged-Image File Format. This format was developed by Aldus and Microsoft to represent pixel-based images, such as those produced by scanners.

Tile: To fill an area with small, regular shapes or blocks of patterns.

Track: Moving the camera up, down, or sideways in relation to the scene.

Transparency: The characteristic of allowing an underlying image to show through, either partially or totally.

Tumble: Rotating a camera's view around a particular object.

Vertex: A point of intersection of two vectors or a point used to define a polygon.

Volumetric Mapping: A process in which a map is defined as a 3-D volume, but which is only visible on the surface of an object. The object has the appearance of being carved out of the volume. Volumetric maps may also be used to define multiple surface characteristics.

Window: An element of a desktop interface that contains one or more views of the 3-D model. There are several types of windows used in Strata 3D.

Wireframe: A fundamental rendering method that represents 3-D objects with connecting lines. No surfaces are shown, but may be implied if hidden lines are removed for the resulting image.

X-Axis: The horizontal axis which represents width.

Y-Axis: The vertical axis which represents height.

Z-Axis: The axis which represents depth.

3D Graphics and Animation Resources

Books:
The Illusion of Life - Frank Thomas & Ollie Johnson
The Animator's Survival Kit - Richard Williams
Inspired Series - Course Technology (www.course.com)

General 3D Web sites:
http://www.3dcafe.com/asp/platinumdefault.asp - 3D Cafe
http://www.3dtotal.com
http://www.awn.com/ - Animation World Network
http://www.cgnetworks.com
http://www.computerarts.co.uk/3dworld - 3D World
http://wwwinsidecg.com
http://www.stratacafe.com - Strata Cafe

Animation web sites:

http://www.awn.com/
http://www.citycafe.com/animation/tools.php
http://www.mouseplanet.com/david/dk030814.htm
http://www.toonhub.com/
http://www.animationmeat.com/

Computer animation web sites:

http://cgw.pennnet.com/home.cfm
http://webdesign.templatemonster.com/cat/3d-graphics/articles/
http://www.highend3d.com

Drawing web sites:

http://drawsketch.about.com/od/cartooning/
http://www.artlex.com/ArtLex/d/drawing.html
http://www.ccds.charlotte.nc.us/green/drawing.htm
http://www2.arts.ubc.ca/TheatreDesign/crslib/index1.htm

Salt Lake City Game companies:
http://sigda.asuu.utah.edu/companies.htm

3D Freeware/Shareware:
http://www.anim8or.com/main/index.html - Anim8or
http://www.blender3d.com/cms/Home.2.0.html - Blender
http://www4.discreet.com/gmax/ - GMax
http://www.wings3d.com/ - Wings 3D

Magazines:
Animation Magazine
http://www.animationmagazine.net/

Software (Programs) Needed:

Operating system software:
Windows with Sound Recorder, CD player, and Volume Control Mixer, or equivalent Macintosh operating system

3-D animation/modeling software:
TrueSpace, 3-D Studio Max, Bryce, Maya, Strata Cinema 4D, Lightwave Etc.

Rastor/Bitmap Software: Photoshop

Vector Software: Illustrator, Flash

Hardware (Equipment) Recommendations for 3D Graphics and Animation:

PC

Pentium III processor (400+ mHz or higher)
1 G RAM
Zip, Jazz drive or equivalent storage device is highly recommended
Hard drive: 6 gig minimum (as large as you can afford)
CD-ROM
High-resolution video card
Sound card/speakers OR
High enough to meet software specifications.

Macintosh

G4 processor (266 mHz or higher)
1 G RAM
Zip, Jazz drive or equivalent storage device is highly recommended
Hard drive: 6 gig minimum (as large as you can afford)
CD-ROM
High-resolution video card
Sound card/speakers OR
High enough to meet software specifications.

* Note: Because of the high processing demands for 3D graphics and multimedia, it is recommended that hardware for 3D graphics/multimedia programs be upgraded at a minimum of every two years. Rotate your 3D/multimedia labs to other labs in the school. Consider leasing agreements to stay current.

Other Equipment Needed (Required):

CD burner
Computer network with large hard-drive storage capacity (10 G+)
Color printer
Scanner
Digital Video and Still Camera
Internet access
LCD projector or equivalent demonstration software

<u>Optional Equipment:</u>

DVD drive
Wacom tablet
3D Printer
Motion Suit
Holographic Projector

Appendix

Fair Use Guidelines for Education:

Motion Media	Up to 10 percent or three minutes, whichever is less
Text Material	Up to 10 percent or 1,000 words, whichever is less, in the aggregate of a copyrighted work
Music, Lyrics, and Music Video	Up to 10 percent, but in no event more than 30 seconds of the music and lyrics from an individual musical work
Illustrations and Photographs	No more than five images by an artist or photographer may be reproduced or otherwise incorporated as part of an qualifying educational multimedia project